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(54) Moving vehicle specification system including an auxiliary specification function

(57) If a vehicle could not be specified by a local controller (10), the license plate number is decoded from a license plate image in a method where a number database (74) is referenced according to grouped information and number information is retrieved. Auxiliary specification of the vehicle is performed through a comparison between the searched result and the decoded result. This prevents any impairment in the real-time performance of the processing based on local controller (10) and permits more accurate vehicle specification.

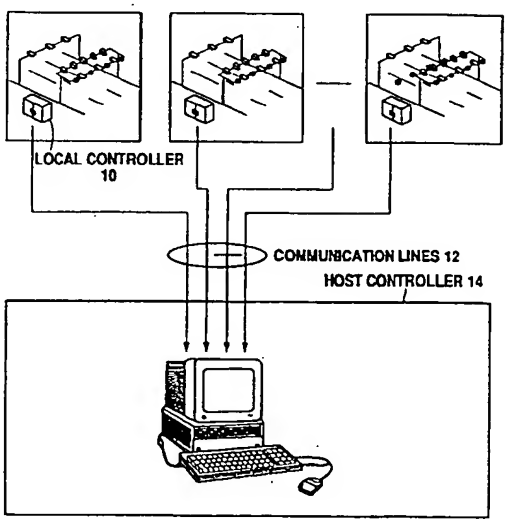

Fig. 1

EP 0 779 600 A2

present invention lies in providing auxiliary specification means for specifying moving vehicles that the primary specification means failed to specify. The auxiliary specification means specifically references the number database with the identification information, and compares the result with license number images obtained from photographs of the vehicle passage positions or their vicinity, thereby the vehicle detection information and/or identification information and the number information are correlated. The number database mentioned here stores a correlation of number information inscribed on the license plates of the vehicles with the corresponding identification information for vehicles having identification information.

According to the present invention, after most of moving vehicles are specified based on the correlation of vehicle detection information and identification information, auxiliary specification of at least those moving vehicles for which the specification was not successful is executed, by comparing the number information obtained from a search of the number database with the license number images obtained from photographs. Therefore, according to the present invention, the trade off between the real-time performance and the specifying accuracy can be resolved or improved since a design or functional assignment is possible, for example, where processing based on the specifying means is executed with priority on the real-time performance, and the auxiliary specifying means compensates for the inaccuracy of the specifying means. For example, when the present invention is applied to the previously proposed system, the occurrence of vehicles regarded as illegal even though they have been properly debited is reduced, while at the same time the real-time processing performance is maintained. Effects that are identical or similar to the related effects are also produced when this configuration is applied to other types of vehicle moving control or management systems.

The arrangement of the various functions comprising the present invention can be designed in various ways. As an example, an embodiment can be presented wherein multiple local controllers arranged along a road are each provided with a communication means, a vehicle detection means, and a specification means, while on the other hand, the host controller, which inputs the specification results, vehicle detection information and identification information for which the corresponding specification means failed at correlation, and the above-mentioned license number images, from the specification means in these local controllers is provided with the number database and the above-mentioned auxiliary specification means. Since the number database is centrally arranged in the host controller and the auxiliary specifying is executed by the host controller in the present embodiment, the operator, during license number data maintenance (for example, registering new license numbers for vehicles assigned with identification information), need only perform maintenance on the number database in the host controller, and not for the local controllers that are usually provided in multiple numbers. Thus, maintenance becomes comparatively easy. Furthermore, the information stored in the number database includes information that can specify a vehicle or individual, such as the license numbers and identification information of vehicles, and represents the type of information for which high security must be maintained. Achieving a centralized number database in this configuration, namely, avoiding a distributed database, can improve the protection of confidentiality of these types of information.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram representing a configuration of a system related to the first embodiment of this invention.

Fig. 2 is a perspective view showing an external appearance of the vicinity of first and second gantries in this embodiment.

Fig. 3 is a side view showing equipment arranged on the first and second gantry.

Fig. 4 is a block diagram representing a functional configuration of an in-vehicle unit (IU).

Fig. 5 is a diagram depicting an example arrangement of loop coils.

Fig. 6 is a block diagram representing a functional configuration of a local controller.

Fig. 7 is a flowchart showing a flow for a vehicle specifying process in the local controller.

Fig. 8 is a block diagram representing a functional configuration of a host controller.

Fig. 9 is a flowchart showing a flow for a vehicle auxiliary specifying process in the host controller.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of the present invention will be described with reference to the accompanying drawings in which the configuration and functions of the local controller, and the means for debiting, debiting confirmation, vehicle detection, vehicle photography, and so forth, will for simplicity be partially omitted from the description that follows. For their details and modifications, the reader should refer to the series of systems previously proposed by the applicant such as Japanese Patent Application No. Hei 7-82523 and the corresponding US Patent Application.

Fig. 1 shows a general configuration of an automatic debiting system related to the embodiment of the present invention. In the system shown in this figure, a local controller (LC) 10 is arranged at each required (generally multiple) position along an expressway, for example. LC 10 executes the procedure disclosed in Japanese Patent Application No. Hei 7-82523, yielding results such as the specifying of moving vehicles which are gathered at a host controller (HC) 14 via communication lines 12. HC 14 is arranged at a Land Transport

dence calculations regarding the detection data (208) in proportion to the quantity of the obtained detection data.

LC 10 initiates, when the conditions for initiating the vehicle specifying process have been satisfied, for example, after the elapse of a predetermined time (210), the vehicle specifying process (correlation mapping) while using the degree-of-coincidences calculated according to a predetermined algorithm in step 204 or 208 as indexes. At this time, LC 10 selects (212) the detection data to be supplied to the vehicle specifying process from among the detection data stored in the database acquired so far, and supplies the selected detection data one item at a time to the processes relating to steps 214 through 220. In other words, the processes relating to steps 214 through 220 are repeatedly executed for a number of times equal to the number of selected detection data items.

Based on the degree-of-coincidences calculated in steps 204 and 208, the communication data is selected in step 214 for which the correlation to the detection data supplied to the current vehicle specifying process is seen as valid. If the number of communication data items selected in this manner is one or less (216), LC 10 judges (218) that the vehicle 20 relating to the selected one or no communication data is the same as the vehicle 20 relating to the detection data supplied to the current vehicle specifying process. On the other hand, if a multiple number of communication data items is selected (216), LC 10 groups these communication data items and correlates them with the detection data supplied to the current vehicle specifying process (grouping process 220).

After the processes in steps 214 through 220 are executed for all detection data items selected in step 212, LC 10 generalizes the results of the processes based on steps 218 and 220 so that the detection data supplied to the vehicle specifying process is correlated as much as possible to the communication data relating to a single vehicle (confirmation of specifying result 222). LC 10 operates so that a pair of communication data and detection data items (called a "specifying result (normal)" hereinafter) specified as data relating to a single vehicle is transmitted to HC 14 when the correlation is successful, and deleted (224) from the database within central controller 52. For illegal vehicles (for example, vehicles 20 for which debiting was not properly performed due to the shortage of remainder in IC card 42) compressed images of the license plates are also transmitted with the specifying result (normal). The detection data (called a "specifying result (without IU)" hereinafter), which clearly does not have the corresponding communication data, is transmitted together with the license plate images and so forth. Furthermore, the group of communication data and detection data (called "specifying information (unable to specify)" hereinafter), which has been subjected to the grouping in step 220 and for which the specifying of a single vehicle was unsuccessful, is also transmitted together with the license plate images and so forth. After this, the flow of the vehicle specifying process by LC 10 returns to step 202 to enter a standby state for the acquisition of communication data and detection data.

By executing this sort of process, multiple vehicles 20 traveling side by side or multiple vehicles 20 traveling in tandem can be distinguished and accurately correlated with the communication results and/or the license plate images even if the communication coverage for debiting antennas 22 and debiting confirmation antennas 26 is set to a wide area. Furthermore, by executing the processes shown in Fig. 8 and Fig. 9 at HC 14, vehicle specification (auxiliary specification) is possible in this embodiment, even with regard to specifying information (unable to specify) that is transmitted from LC 10.

Viewed functionally, HC 14 includes a result registration/illegal vehicle processor 66 and a vehicle auxiliary specifying section 68. The result registration/illegal vehicle processor 66 generally gathers specifying results (normal) and specifying results (without IU) from multiple LCs 10, registers the results to the internal database, and executes a predetermined process such as formal notice or black list registration regarding illegal vehicles based on the specifying results (without IU) and so forth. Result registration/illegal processor 66 also executes the same processes regarding the auxiliary specifying results (normal) and the auxiliary specifying results (without IU), which are supplied from vehicle auxiliary specifying section 68 and described later, as those regarding the specifying results (normal) and the specifying results (without IU) from LC 10, respectively.

Vehicle auxiliary specifying section 68 comprises a number decoder 70, a registered vehicle searcher 72, a number database (NDB) 74, and an auxiliary specifying section 76. As shown in Fig. 9, when vehicle auxiliary specifying section 68 inputs (300) information that LC 10 has grouped in step 220, namely, specifying information (unable to specify), the license number images that are the results of photography by enforcement cameras 24 and the detection data representing information obtained by processing the outputs of loop coils 44 and/or line scanners 28 is supplied to number decoder 70, and the communication data obtained by processing the results of communications with debiting antennas 22 and debiting confirmation antennas 26 is supplied to registered vehicle searcher 72. These are registered (302) in an internal auxiliary specifying standby database by number decoder 70 and registered vehicle searcher 72.

After all the specifying information (unable to specify) belonging to a single group is received (304), vehicle auxiliary specification section 68 automatically decodes (306) license numbers from the license number images by number decoder 70. This decoding process is executed for all vehicles belonging to that group. The automatic decoding may be replaced with human-based visual confirmation, with results supplied to auxiliary specifying section 76 to be described later. On the other

further comprising:

local controllers (10), arranged at a plurality of locations along said road, each including said communication means, vehicle detection means and specifying means; and
a host controller (14), having said number database and said auxiliary specifying means, for inputting specifying results by specifying means, vehicle detection information and identification information for which the corresponding specifying means failed at correlation, and said license number images from a plurality of local controllers.

3. A vehicle specification system according to claim 1, wherein

said communication means, by performing radio communications regarding at least debiting with said moving vehicles, performs radio reception from vehicles of identification information unique to the vehicles; and

said vehicle specifying system is an automatic debiting system for automatic debiting against said vehicles and detecting illegal vehicles.

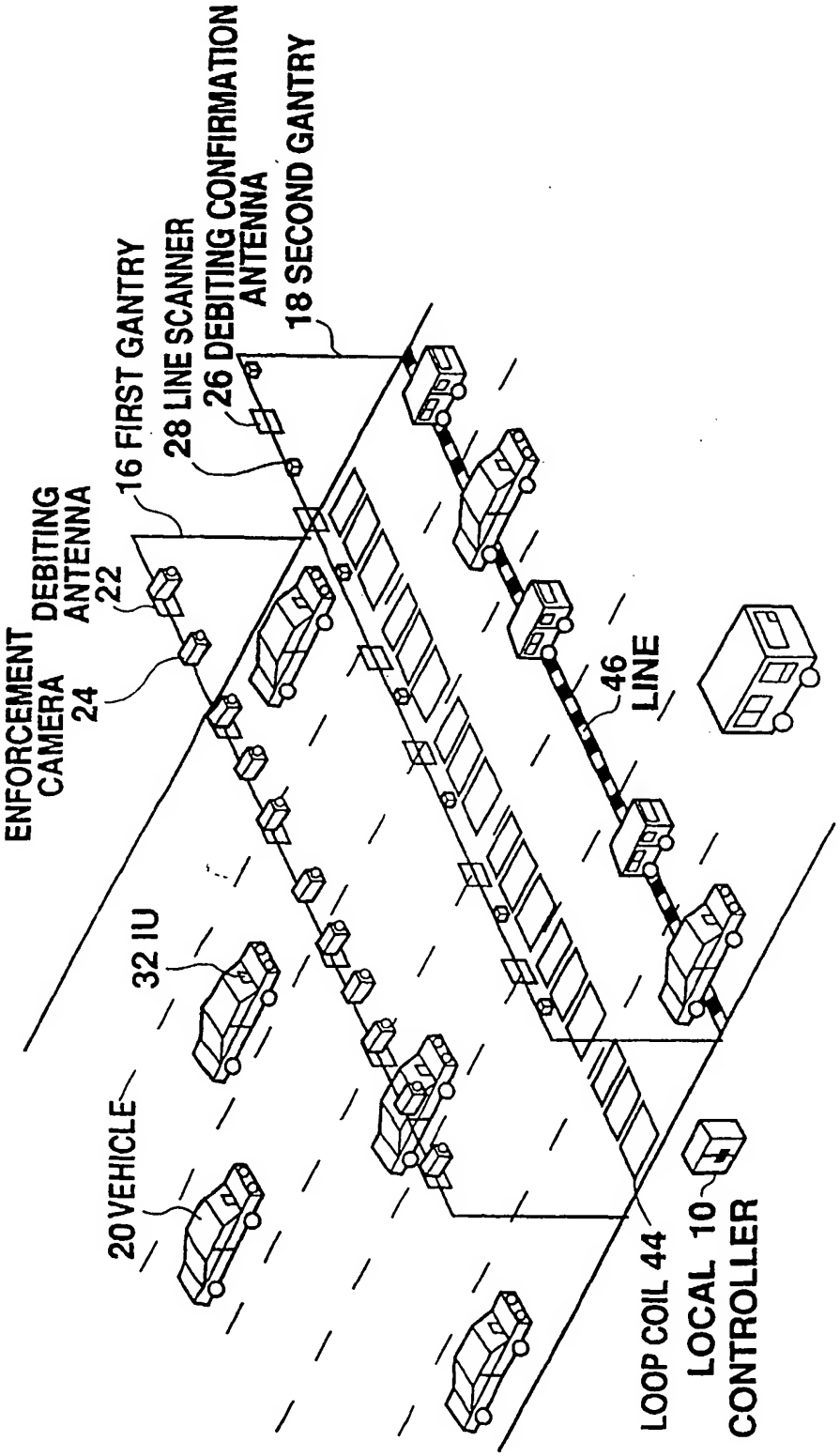
18 SECOND GANTRY
26 DEBITING CONFIRMATION ANTENNA
28 LINE SCANNER
16 FIRST GANTRY
DEBITING ANTENNA 22
ENFORCEMENT CAMERA 24
46 LINE
32 IU
20 VEHICLE
LOOP COIL 44
LOCAL 10 CONTROLLER

Fig. 2

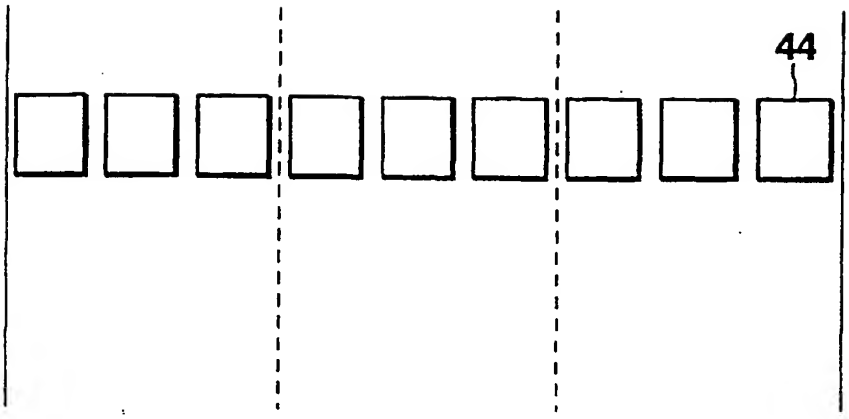

Fig. 5

VEHICLE SPECIFICATION FLOW

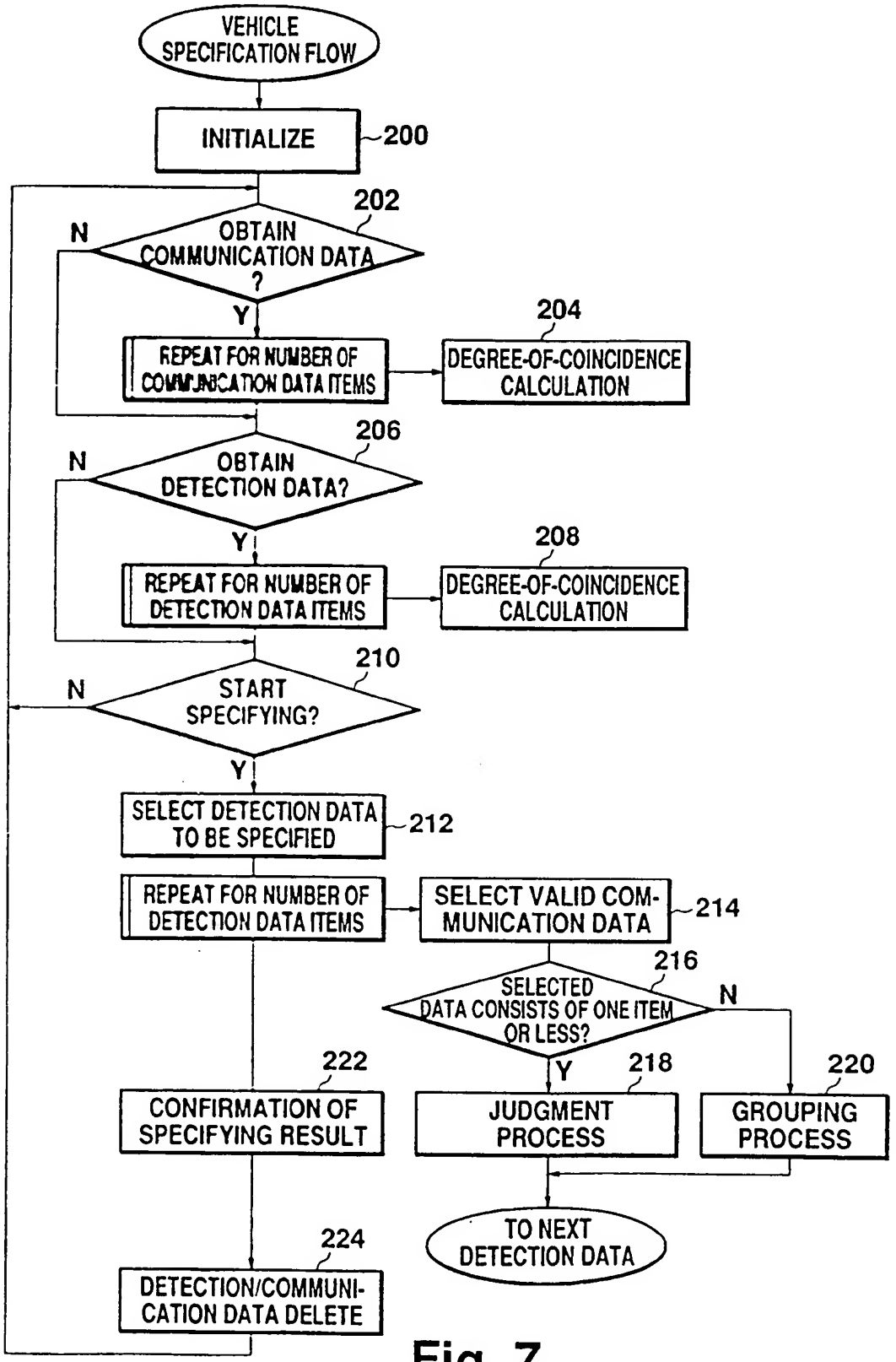

Fig. 7

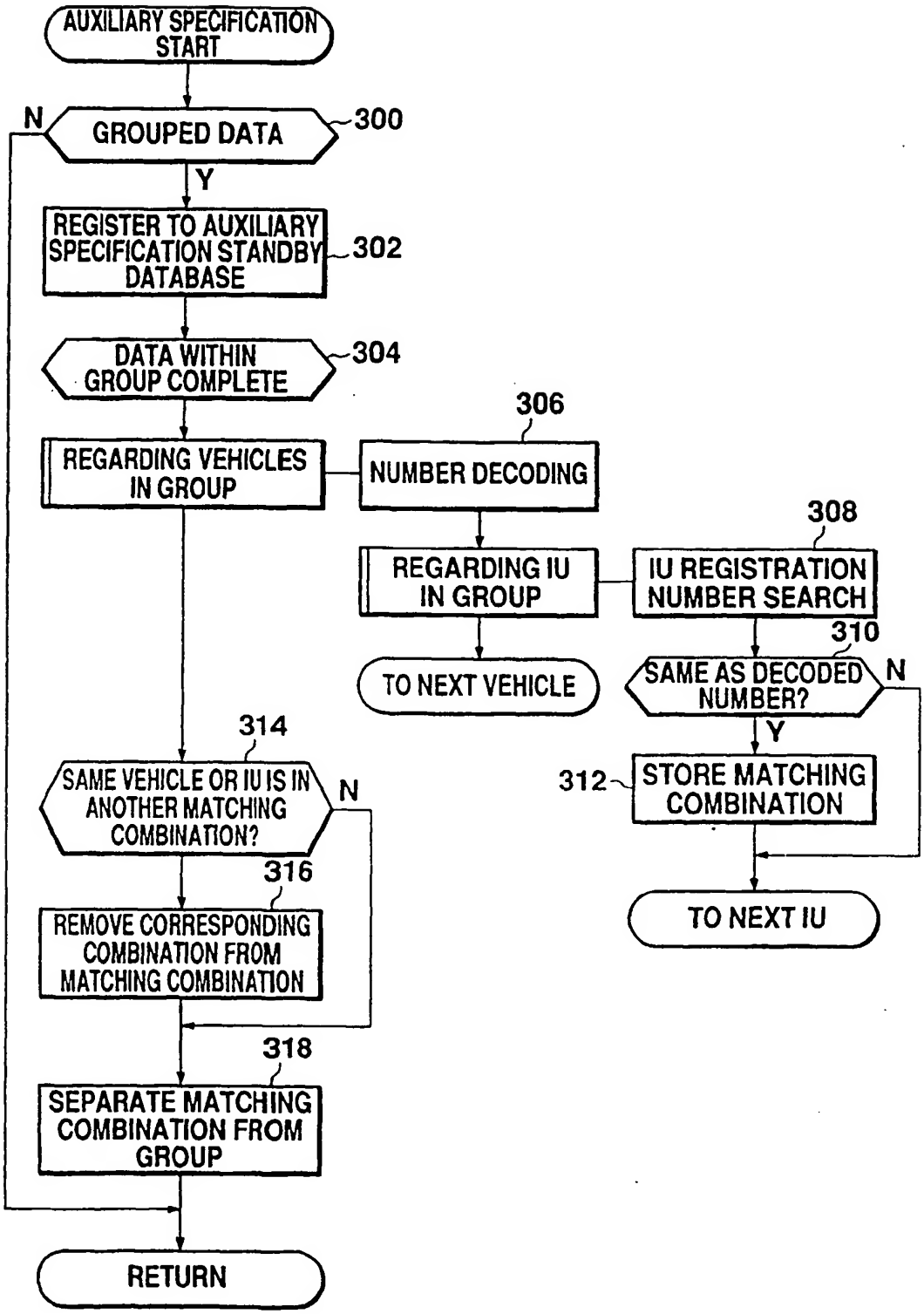
AUXILIARY SPECIFICATION START
GROUPED DATA
300
N
Y
REGISTER TO AUXILIARY SPECIFICATION STANDBY DATABASE
302
DATA WITHIN GROUP COMPLETE
304
306
REGARDING VEHICLES IN GROUP
NUMBER DECODING
308
REGARDING IU IN GROUP
IU REGISTRATION NUMBER SEARCH
310
TO NEXT VEHICLE
SAME AS DECODED NUMBER?
N
Y
314
312
SAME VEHICLE OR IU IS IN ANOTHER MATCHING COMBINATION?
N
STORE MATCHING COMBINATION
316
REMOVE CORRESPONDING COMBINATION FROM MATCHING COMBINATION
TO NEXT IU
318
SEPARATE MATCHING COMBINATION FROM GROUP
RETURN

Fig. 9

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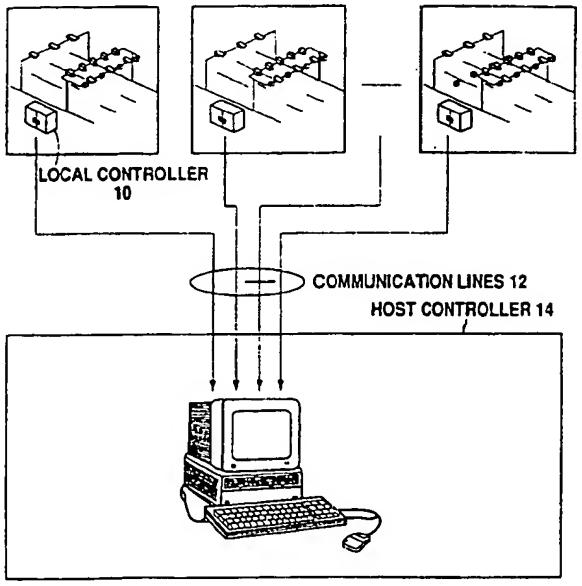

Fig. 1

EP 0 779 600 A3

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 96 11 9865

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